Communications of the Association for Information Systems

Volume 34 Article 32

1-2014

Full Information Product Pricing: An Information Strategy for Harnessing Consumer Choice to Create a More Sustainable World

Luis F. Luna-Reyes
Escuela de Negocios, UDLAP México, luisf.luna@udlap.mx

Jing Zhang
Graduate School of Management, Clark University

Andrew Whitmore
Department of Information Systems and Decision Science, University of South Florida

Holly Jarman
Center for Law, Ethics & Health/Department of Health Management & Policy, University of Michigan

Sergio Picazo-Vela
Escuela de Negocios, UDLAP México

See next page for additional authors

Full Information Product Pricing: An Information Strategy for Harnessing Consumer Choice to Create a More Sustainable World

Authors
Luis F. Luna-Reyes, Jing Zhang, Andrew Whitmore, Holly Jarman, Sergio Picazo-Vela, Deborah Lines Andersen, Giri K. Tayi, Theresa A. Pardo, Djoko S. Sayogo, Joanne S. Luciano, and David F. Andersen

Communications of the Association for Information Systems

CAIS

Full Information Product Pricing: An Information Strategy for Harnessing Consumer Choice to Create a More Sustainable World

Luis F. Luna-Reyes
Escuela de Negocios, UDLAP México
luisf.luna@udlap.mx

Jing Zhang
Graduate School of Management, Clark University

Andrew Whitmore
Department of Information Systems and Decision Science, University of South Florida

Holly Jarman
Center for Law, Ethics & Health/Department of Health Management & Policy, University of Michigan

Sergio Picazo-Vela
Escuela de Negocios, UDLAP México

Deborah Lines Andersen
College of Computing and Information, University at Albany

Giri K.Tayi
School of Business, University at Albany

Theresa A. Pardo
Center for Technology in Government, University at Albany

Djoko S. Sayogo
Center for Technology in Government, University at Albany

Joanne S. Luciano
Web Science Research Center, Rensselaer Polytechnic Institute

David F. Andersen
Rockefeller College of Public Affairs and Policy, University at Albany

Abstract:

Research and practice in the information systems (IS) field have been evolving over time, nourishing and promoting the development of applications that transform the relationships of individuals, corporations, and governments. Building on this evolution, we push forward a vision of the potential influence of the IS field into one of the most important problems of our times, an increasingly unsustainable world, which is traditionally considered the product of imperfect markets or market externalities. We describe our work in Full Information Product Pricing (FIPP) and our vision of a FIPP global socio-technical system, I-Choose, as a way to connect consumer choice and values with environmental, social, and economic effects of production and distribution practices. FIPP and I-Choose represent a vision about how information systems research can contribute to interdisciplinary research in supply chains, governance, and market economies to provide consumers with information packages that help them better understand how, where, and by whom the products they buy are produced. We believe that such a system will have important implications for international trade and agreements, for public policy, and for making a more sustainable world.

Keywords: information systems research, economics of information, supply chain management, Full Information Product Pricing

Editor's Note: The article was handled by the Department Editors for Information Technology and Systems

Volume 34, Article 32, pp. 637-654, January 2014

I. FULL INFORMATION PRODUCT PRICING: A FUTURE POSSIBLE VISION

Most products are mass produced and distributed through cost-effective distribution networks that reduce inventory costs and deliver uniform-quality products to end consumers in a way that minimizes overall product price. These manufacturing and distribution techniques typically do not reveal certain types of information to end consumers. However, a growing number of ethical (e.g., "artisan," "local," "fair trade," "green") consumers, producers, and retailers are increasingly paying attention to information about where, when, how, and by whom food, consumer, and durable goods are produced [Bray, Johns, and Kilburn, 2011; Goleman, 2009; Watts and Wyner, 2011].

For instance, organic food market penetration grew an average of 16.5 percent in the U.S. from 2000 to 2010 [Organic Trade Association, 2011]. Fair trade markets have grown 20 percent in Europe and 40 percent annually in the U.S. and the Pacific Rim [Kim, Lee, and Park, 2010], and free-range eggs accounted for 27 percent of UK egg production [Low and Davenport, 2007]. Unfortunately, information needed by ethical consumers during the buying process is rarely available [Graham and Haarstad, 2011]. Information about product sourcing is systematically stripped away in long supply chains, and consumers are presented only with a final product and its final price. Moreover, market premiums for organic, fair trade, and environmentally-friendly products offer an incentive to "green-wash" products, increasing profitability for the manufacturer or retailer and introducing the need for trustable product- or company-related information.

Consumers who might care about pollution generated in producing their purchases or exploitative labor associated with these same purchases are spared the bother of contemplating these "unintended consequences" of competitive markets by a convenient lack of information—by persistent information asymmetries—information known within the supply chain but unknown to the customer at the point of purchase. In fact, the lack of trustable information, as well as the lack of transparency in supply chains, has been identified as one of the main barriers to increasing ethical consumption [Bray et al., 2011; Carrington, Neville, and Whitwell, 2010; Goleman, 2009].

At a macro level, market theorists suggest that many of these adverse side effects of information-starved consumer markets should be classified as "externalities"—unknown, unintended, and presumably unknowable and unfortunate consequences of production practices that feed products to markets where perfect information is an assumed reality that permits externalities to thrive in the shadows of asymmetric information.

What should be done with these accumulating market externalities? As they pile up, our world becomes less sustainable, resource stocks are depleted, unusable toxic by-products of production processes accumulate, and human capital and social infrastructure are left to decay. Modern market theory suggests that if these unsustainable and accumulating externalities get to be too bad, a justification for government intervention with some form of market regulation exists. But a popular ideology of "free market" politics blocks such intervention. Moreover, government regulations are limited by borders and differ from one country to another in an international-global system. Thus, the race toward an increasingly unsustainable world continues unabated.

Our vision is to use the full power of information systems to return as much information as possible to consumer markets—to give consumers as near-to-perfect information as possible. Consumers would receive information about how, when, where, and by whom their products came to be. Our vision is to make modern consumer markets more like David Ricardo's [1817] and Adam Smith's [1776] meeting places of perfect information.

Although understanding ethical consumption is still a work in progress for marketing researchers [Bray et al., 2011; Carrington et al., 2010; Kim et al., 2010], we believe that many consumers who know about unsustainable externalities will be willing to pay a price premium to procure more sustainable products. If trusted information can be brought comprehensively to consumer markets, producers and supply chain managers will begin to compete by producing more sustainable products that are more attractive to more consumers [Goleman, 2009].

We call this vision "Full Information Product Pricing" (FIPP). To present the vision, the article is organized in five sections. This introduction constitutes the first of these. The second section includes the research processes that led us to the development of the FIPP concept. Next, the third section describes the social and technical components of a prototype system, I-Choose, which currently is a main focus of the research of our group. In the fourth section we describe our current efforts in the developing of I-Choose. We finish the article with a brief discussion and reflection on the relationships among challenges and research questions.

II. A THREE-STEP PROCESS TO DEFINE FULL INFORMATION PRODUCT PRICING (FIPP)

Our current conceptualization of Full Information Product Pricing systems has emerged from a research project motivated by four recent consumer market trends. First, product labeling is a trend designed to return more information to consumers about the products they purchase [Caswell and Padberg, 1992]. A second trend consists of local or artisan production methods and their associated supply chains. A third trend is related to product traceability [Hobbs, 2004; Regattieri, Gamberi, and Manzini, 2007; Eamich, 2007]. A fourth trend uses either Web- or mobile-based tools to bring information to final consumers. Although Good Guide is perhaps the best known of all these applications, there are more than forty iPhone apps for ethical consumers [Watts and Wyner, 2011].

As described in Exhibit 1, our research project has followed a three-step approach to define FIPP. The first step was to identify and analyze cases where FIPP systems were already in place. This exploration took place during the three first months of 2008. We conducted four initial case studies, two from Canada, one from Mexico, and one from Central America. Data gathering for the case studies included document analysis, as well as semi-structured interviews with managers and participants from each case. The cases included cooperatives and small and medium enterprises using a variety of tools to attach trusted non-price information to products in order to charge a price premium [Luna-Reyes, Zhang, Roy, Andersen, Whitmore, and Andersen, 2013].

Step 1: Study Cases Where We Believe FIPP Is Already in Place The first step involved locating and studying a series of case examples where producers were already successfully using information strategies to create tighter linkages with their end customers, enabling producers to charge a price premium for their products [Luna-Reyes et al., 2013].
Step 2: Step Back and Look for General Patterns Combining our case studies with other background readings and Internet research, we were able to identify six distinct patterns of Full Information Product Pricing networks, as well as six cross-cutting policy issues in these networks [Whitmore, Andersen, Zhang, and Luna-Reyes, 2010].
Step 3: Envision a Scalable, Internet-enabled Open Source FIPP System Our current research focuses on developing a socio-technical FIPP system, I-Choose. I-Choose consists of a "mash-up" of the existing FIPP types, building on their collective strengths and seeking to compensate for some of their weaknesses. The system is conceptualized as a set of open semantic technologies and standards, managed by a network of organizations representing consumers and supply chain participants.

Exhibit 1. Three-step Process to Define Full Information Product Pricing (FIPP)

Our initial case exploration allowed us to identify six ideal FIPP types (Table 1). They are face-to-face producer-to-consumer networks, voluntary certification organizations, government-sanctioned certification regimes, consumer-driven social computing systems, proprietary supply-chain-driven systems, and mobile technology-mediated ethical consumption tools (MTEC—this last term was initially introduced by Watts and Wyner [2011]). We will describe these ideal types with more detail in the following section, together with six key policy issues associated with FIPP [Whitmore et al., 2010].

Our current research focuses on the development of I-Choose, a prototype of a FIPP system. Following a design science approach [Hevner, March, Park, and Ram, 2004; Peffers, Tuunanen, Rothenberger, and Chatterjee, 2007], I-Choose is being designed as a "mash-up" of the existing FIPP types. I-Choose is envisioned as a socio-technical system to be enabled by open technologies such as the semantic Web, Web 2.0 social computing systems, mobile apps and standards-based interoperability that would allow large scale systems to be built in an open-source environment that still retains many of the desirable features of smaller scale, even face-to-face, systems. In addition, I-Choose would be both driven and supported by a number of social forces. Particularly, a network of consumer advocates, producers, and other supply chain participants will be figuring out how to use the public drive for accountable, transparent, and sustainable systems to create new opportunities to secure market share and return profits to shareholders.

General Patterns and Cross-cutting Issues in FIPP Regimes

Table 1 summarizes patterns as well as cross-cutting issues among the six FIPP ideal types that we have identified: face-to-face producer-to-consumer networks (farmers' markets), voluntary certification organizations (Fair Trade Labeling Organization, Rainforest Alliance), government-sanctioned certification regimes (USDA Organic, USDOE

Energy Star, FDA nutrition labels), consumer-driven social computing systems (Citizens Market, BILUMI, El Poder del Consumidor), proprietary supply chain-driven systems (Walmart Sustainability Index, NuVal), and mobile technology-mediated ethical consumption tools (MTEC examples include GoodGuide, Barcoo, Non-GMO, HarvestMark, WeGreen).

Each type provides certain advantages for designing scalable FIPP regimes. However, each of these models has limitations. For example, face-to-face networks are based on high levels of trust (like farmers' markets). Although this type of producer-to-consumer trusted network is the "gold standard" that other FIPP systems aspire to emulate, face-to-face networking does not scale well to mass consumer markets. Voluntary certification organizations rely on standards established by nongovernment organizations such as the Fair Trade Labeling Organization (FLO). One problem with these systems is the diversity of standards and the lack of maturity of certification systems across organizations.

Government-sanctioned certification regimes (like USDA), on the other hand, rely on national norms, laws, and regulations, usually implemented through independent certification organizations accredited by government standards. Producers or consumers (through taxes) assume the high level of costs ensuring that the certifications comply with each country's standards. Another variety of FIPP system consists of networks of consumers who report on environmental, social, or ethical practices in organizations and share the information with other consumers. These networks typically communicate through social media and Web 2.0 applications (see http://civic.mit.edu/projects/community/citizens-market, http://civic.mit.edu/projects/community/buy-it-like-you-mean-it/ and http://www.elpoderdelconsumidor.org/. They are inexpensive. However, it is difficult to ensure the quality of consumers' evaluations, and it is hard to sustain these efforts over time. Proprietary initiatives, such as Walmart's program to develop a "Sustainability Index," Starbucks' C.A.F.E. program, or the NuVal food scoring system, constitute a fifth kind of FIPP system. The Walmart index may have the advantage of collecting data throughout the supply chain. The disadvantages are the high level of cost in implementation to both the supplier and producer and the potential conflict of interests. The C.A.F.E. program is Starbucks' quality verification using production, environmental, and social practices. The C.A.F.E. standard was developed by Starbucks and Conservation International. NuVal is a proprietary system that depends mainly on its adoption by retailers. Being a proprietary system, it also lacks the necessary transparency for consumers and other stakeholders.

Finally, MTEC, such as GoodGuide or Barcoo, are typically private ventures that use product- and company-related information to offer consumers ratings on health, environmental, and social impacts. These tools use publicly available information or sometimes information they get through partnerships with information providers. Portability and accessibility are some of the strengths of these systems. The simplicity of the rating systems is another important strength. Moreover, being sponsored by independent third parties, they are capable of building reasonable levels of consumer trust. However, these systems require intense use of expert time to rate products and companies and involve human judgment and weight selection that make it very difficult to have a transparent system for consumers and other stakeholders. Although some MTEC tools involve scientists and experts in the rating development process and the rating itself, they do not have a third-party verification, and consumers need to assess information sources for themselves, rating mechanisms and organizational intentions. Finally, developing a business model of these ventures is still a work in progress, making it hard to predict their sustainability in the long run.

As it is shown in Table 1, key dimensions to understand differences and similarities among FIPP types include governance and control mechanism, consumer-to-producer connections, information collection and dissemination cost, data quality, and independent verification, as well as consumer trust. A creative combination of all these elements will be necessary if FIPP systems are to meet the dual demands of providing consumers with trusted information and allowing the system to scale to the size necessary for mass consumer markets.

Table 1: Cross-cutting Policy Issues Across Various Types of Full Information Product Pricing (FIPP) Regimes (Extended from Whitmore et al., 2010)

FIPP Type	Underlying values	Governance, Oversight, and Control	Consumer-to-Producer Connections—supply chain issues	Who Pays? (and financial incentives)	Data Quality and Independent Verification	Consumer Trust	Examples
Face-to-face Producer-to-Consumer Networks	Replicate traditional communities of trust	Individuals know and trust each other.	Personal connections and trust dominate supply chain.	Trusted information is integrated seamlessly into final product price.	Trusted relationships obviate need for data verification.	"Gold standard" model based on personal knowledge and trust	Farmers' markets
Voluntary Certification Organizations	Producers certifying compliance with standards	Typically NGOs linked to producer organizations with some retail networks	Certification focuses on producers/ consumer confidence critical.	Producer organizations or coops pay fees to certifying agencies.	Voluntary self-reporting with diverse verification standards	Depend on reputation of certifying organization at consumer sites	Fair trade labeling organization, Rainforest Alliance, Fair Trade Federation, ISO standards
Government Sanctioned Certification Regimes	Government certifies compliance with standards	Government agencies with legal mandate and sanctions	Often entails complete monitoring of complete supply chain	Taxpayers support consumer protection functions, and producers pay fees to certifying agencies.	Data quality and independent verification and inspection key components	Usually high, can be tempered by cynicism about industry lobbying efforts	USDA Organic, Energy Star, FDA Nutrition Labels
Consumer-driven Social Computing Systems	Consumers inform each other of compliance with standards.	Loose networks of like-minded consumers	Consumers provide opinions on producer and supply chain practices.	Typically low cost, relying on consumer input to populate evaluations	No independent check on data quality beyond crowd sourcing	Social networks typically create high consumer trust.	Citizens' market, Bilumi.org, El Poder del Consumidor
Proprietary Supply-chain Driven Systems	Commercial interests align with consumer confidence.	Corporate integration by dominant retailer, vertically integrated supplier or specific aspects of supply chain	Data systems track some aspects of production for complete or part of the supply chain.	Tracking systems incorporated into production and distribution costs	Profitability depends on reliable supply chain data, but no third party verification.	Consumers must assess information sources and corporate intentions.	Walmart sustainability index, NuVal
Web and Mobile Technology-mediated Ethical Consumption Tools	For-benefit ventures providing third-party, independent product ratings	Private organization or NGOs, sometimes in partnership with information providers	Organization works as an independent expert providing ratings on the basis of publicly available or third-party proprietary information.	Services sold by the organization, advertising and other donations and sponsorships	Verification by experts and researchers inside the organization, but no third-party verification	Consumers must assess information sources, rating algorithms and organizational intentions.	GoodGuide, Barcoo, Non-GMO, What's on my food, HarvestMark, WeGreen

Communications of the Association for Information Systems

Envisioning a Scalable, Internet-enabled Open Source FIPP System

Recent developments in Web and mobile technology-mediated ethical consumption tools constitute a viable alternative to promote more sustainable consumption patterns. However, we believe that current developments can be improved by building into them some of the key features and strengths of the other five types and seeking to compensate for some of their weaknesses. This FIPP type is enabled by technologies similar to MTEC such as the semantic Web, Web 2.0 social computing systems, and mobile apps. However, as pointed out in the previous section, one of the main limitations of current systems is data availability and provenance.[1] In this way, we need to take into consideration alternatives for building an information architecture to increase transparency to supply chain operations and to MTEC ratings. Such an infrastructure should include standards-based interoperability that would allow large-scale systems to be built in an open-source environment that still retains many of the desirable features of smaller scale systems, perhaps even the features of face-to-face exchanges. In recent years researchers have acknowledged a need for provenance interoperability across systems [Moreau, 2010]. In the context of I-Choose, a supply chain may span several organizations. As such, a common representation of provenance becomes necessary to ensure an integrated record can be produced.[2]

In addition, this improved version of a MTEC tool would be both driven and supported by a number of social forces. An invigorated network of consumer advocates supported by innovative forms of government regulation and a redefined environment of accountability and transparency will lead to the development of scalable systems that retain trust while achieving ease of adoption and use by end users. A new generation of socially responsible organizations will be figuring out how to use the public drive for accountable, transparent, and sustainable systems to create new opportunities to secure market share and return profits to shareholders. In the next section, we describe in more detail ideas related to this improved MTEC system.

III. I-CHOOSE: A SOCIO-TECHNICAL RESEARCH PROGRAM TO CREATE SCALABLE FULL INFORMATION PRODUCT PRICING NETWORKS

In this section we imagine a future-possible "mash-up" of some of the FIPP regimes' existing features, an "I-Choose" Full Information Product Pricing system. We aim to explain key components of the system and the roles of the various actors who would be involved in such a system, as well as the difficulties they face using this functionality. We start the description with a consumer vignette.[3]

Ellen Richardson has always considered herself to be a careful shopper. Living with her husband and three children on a limited budget, it has always been a struggle to make ends meet, while at the same time striving to make purchases that reflect her personal commitments to social justice and environmental sustainability. This is why she was the first in her network of friends to download the I-Choose app to her phone. She simply scans the UPC sticker on products she is interested in, and information about how and by whom they were produced is delivered to her. I-Choose allows her to create her own value profile so that product ratings she has previously provided reflect her personal preferences, creating a price-value rating that she can tailor to meet both her budget and her values. In the past, Ellen was one of those shoppers who paid more attention to the unit pricing label than the price itself. Now the I-Choose rating augments unit pricing with value pricing. Today, as Ellen shopped for coffee on the Fair Trade and Organic shelf in her local supermarket, she was surprised that her I-Choose scan revealed a new product on the shelf that made an even better price and value fit for her. She probed the I-Choose profile on that product by drilling down with several clicks. Ellen found out that the product is distributed by StarCents, a coffee distribution firm that is excellent at holding down shipping and distribution costs. It is also shade grown at the Velazquez Coffee Cooperative in Mexico, with a much higher environmental sustainability index at the point of production than her previous coffee purchases. Two more clicks confirmed to Ellen that the Velazquez Cooperative has been certified by the United Fair Trade Association (UFTA) and is well-rated by the Consumer Values Institute, an online social network of consumers who share Ellen's values. Ellen picked up this new brand and dropped it into her cart to give it a try.

---

[1] Provenance is defined in the *Oxford English Dictionary* as: (i) the fact of coming from some particular source or quarter; origin, derivation. (ii) the history or pedigree of a work of art, manuscript, rare book, etc.; concretely, a record of the ultimate derivation and passage of an item through its various owners. With the established rise of consumer interest in establishing the origin and creation of products, the usage of provenance is now actively being applied in both the food and drug industries [Moreau, 2010].

[2] As of 2010, the World Wide Web Consortium has formulated a working group for Provenance, tasked with developing an interoperable model of provenance (http://www.w3.org/2011/prov/wiki/Main_Page), which includes an RDF-based representation (http://www.w3.org/TR/prov-o/)—capable of preserving both derivation details and metadata about referenced entities. It is envisioned that this model will be usable for a variety of use cases similar to Ellen Richardson's coffee purchasing (described in the next section of this article).

[3] This description of I-Choose was included initially as part of a paper presented at the 2011 APPAM Research Conference.

How the I-Choose System Works from a Consumer's Point of View

Ellen is concerned about all of the attributes of her coffee that she can discern directly by inspection in the supermarket: cost, quality, degree of roast, and other product features such as packaging and visual appeal. However, Ellen may also be interested in a number of other unobservable attributes of her coffee—features that are not known to her but are known within the supply chain and not brought to the marketplace. She seeks more information by asking questions such as: How was her coffee grown—organically or locally? Was the farmer paid a fair wage? Do the workers who processed her coffee get healthcare benefits? What is the environmental impact of the coffee's production? Ellen is one of those consumers who is willing to pay a price premium for coffee that is produced in ways consistent with her values.

The I-Choose system has three basic operational components. First, Ellen will be shopping with a handheld shopping support device such as a smart phone. Ellen will be able to scan the UPC code of her purchase so that her smart shopping device can identify the unique product. Her smart phone device will then connect to the Internet and look up information on her chosen product, using an advanced consumer preference application to sort through the information packages available for each uniquely identified product in order to do true comparison shopping.

The second component of the I-Choose system is a standards-based product information data architecture. It will allow multiple stakeholders to seamlessly exchange data in order to assemble in real time an information package describing the details of Ellen's coffee purchase.

The final major component of the I-Choose prototype system is animated by the power of Web 2.0 social computing platforms to produce trusted and easy-to-understand information. Conflicting certification and verification structures will undoubtedly complicate the decision processes of ordinary users when sorting through vast amounts of information. Consumer advocates will fill the gap by establishing peer-ratings systems that pour over data, and arrive at peer evaluations to be disseminated to ordinary consumers who share values with the consumer advocate organizations.

How the I-Choose System Works from the Point of View of Supply Chain Organizations

Ellen Richardson, our hypothetical customer now doing most of her shopping using the I-Choose system, provides a powerful economic motive for supply-chain retailers, producers, and other participants to get involved in providing the information that she seeks. The value of the I-Choose information standards depends on collaboration and agreement among the main actors in the supply chain and other stakeholders such as communities of consumers, producers, retailers, importers, third-party certifiers, and government regulatory agencies. These standards could provide a cheap, reliable, broadly adopted, and government-sanctioned way to deliver trusted information to a widely-dispersed customer base.

Another key component adding value is the presence of a small industry of consumer advocates hosting integrated indices, indicators, endorsements, and sanctions for specific products that are easy for Ellen to use and interpret. This could constitute an information marketplace providing Ellen with many competing, value-driven indicators. No matter what Ellen's values are, there should exist an information aggregator trying to draw her attention to his or her product-rating scheme—all of which becomes possible because of the existence of a common I-Choose information architecture.

Successful implementation of I-Choose will require both the system and consumer to access data that have been formally encoded to capture details of the product supply chain. Ellen Richardson illustrates this need when she interacts with I-Choose to obtain a recommendation for a new coffee brand. In order for the I-Choose system to establish its recommendation, it would have to obtain a record stating the following information:

1. The new coffee brand was distributed by StarCents, which obtained this coffee from the Velazquez Coffee Cooperative, the coffee farmer in Mexico.
2. The Velazquez Coffee Cooperative is certified by the United Fair Trade Association (UFTA).
3. The Velazquez Coffee Cooperative is well-rated by the Consumer Values Institute, an online social network of consumers who share Ellen's values.

Here the ability to link the coffee brand back to its distributor, StarCents, and the Velazquez Coffee Cooperative, its grower (1 above), can be established through a record of provenance. Likewise, (2) and (3) require that metadata corresponding to the Velazquez Coffee Cooperative be maintained.

The extended use of the I-Choose information architecture has the potential ability to promote corporate social responsibility and transparency efforts. That is to say, the potential market value of consumers such as Ellen may

promote corporate attention to the working conditions within their supply chains and the impact of their production processes on the environment. This same potential value might increase retailers' willingness to stock their shelves with products defined by conditions in the supply chain in addition to traditional price and quality considerations.

How Do Individual Organizations Interact with I-Choose in an Integrated Way?

Of course, a major problem with delivering information packages to support value-based shopping is understanding how any given organization can connect without compromising the design and proprietary information housed within its own information systems.

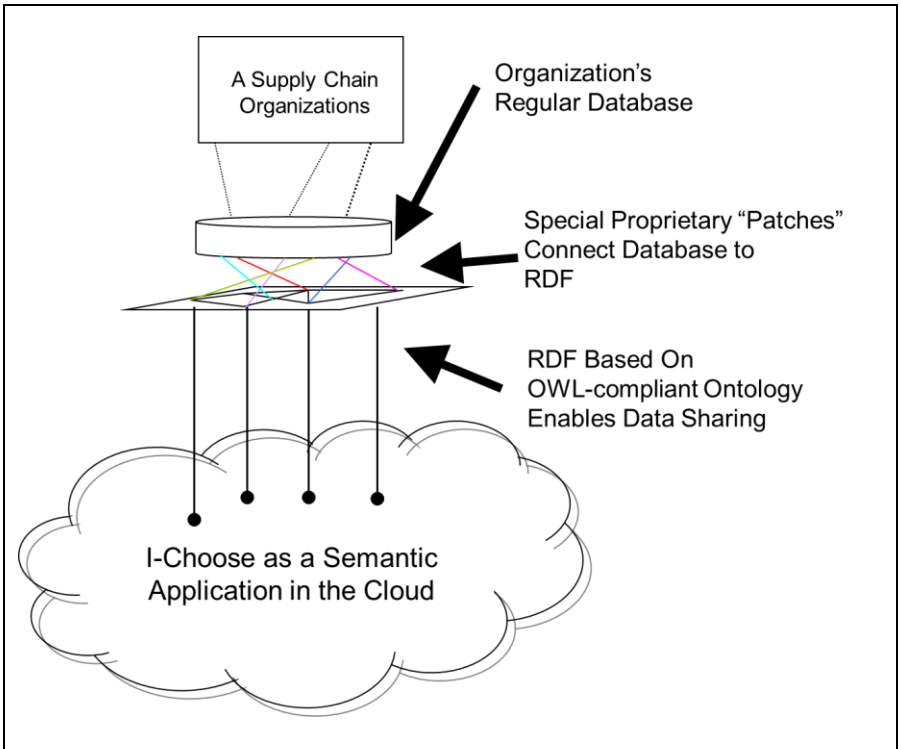

Figure 1. Mapping a Proprietary Database to Open XML Standards[4] for Information Sharing

Figure 1 gives a hint of how this problem can be initially resolved. The key to understanding how this works is to recognize that there is no need to change the way that the existing information systems operate for any organization in the supply chain. Information systems do not need to "talk" directly to other organizations' information systems on the Internet. Rather, some abstraction of an organization's databases is made available on the Internet by mapping its proprietary data architecture to a Resource Description Framework (RDF-based) standard. This approach has the effect of enabling interoperability through a common data architecture and enabling the shielding of private corporate or customer information. This idea is really quite common. As early as the late 1990s, most businesses have made an abstract of key information about their products, services, and terms and conditions of services available on the Internet using HTML—we call this a "Web presence." In later stages, many companies have taken advantage of RDF, a powerful language for data organization and sharing that integrates well into the existing HTML environment.

The tricky part about Figure 1 is that the RDF, or the rules that govern the semantics of the documents, must comply with commonly used and internationally recognized information standards. For example, the Universal Product Code (UPC) is a global industry standard for indexing all types of products using the now familiar product scan bar. If a retailer or wholesaler chooses to use some other product code, its system would not be I-Choose-compliant, unless the retailer/wholesaler takes it upon itself to map its product code to the UPC.[4]

Hence, the structure in Figure 1 implies that all organizations that use the I-Choose standards (1) must have some sort of an automated information system that can be "hooked up" to the Internet and (2) must have their inventory, sales, and shipping systems comply with pre-existing information standards.

[4] See Berniers-Lee [1998].

If these two big conditions are met, every organization also needs to meet a small third condition. Each organization needs to make its I-Choose RDF data publically available on its Web space. Special proprietary "patches" need to be designed to map their regular information systems to RDF. We say a "small" third condition because many businesses are already sharing information with close partners to make their supply chains more efficient. The I-Choose standard intends to make publicly available a subset of the information already being privately exchanged to allow customers to fully evaluate products in the market. Adopting I-Choose information standards provides the producers, distributors, shipping centers, and retailers the means to link to other organizations in a timely manner without the need to build connections one at a time. An I-Choose standard must rely on other widely accepted standards such as XBRL (exTensible Business Reporting Language)[5] for the exchange of financial information, and it must include standards about inspection, auditing, and certification in order to create trust about the information exchanged through the Internet.

What Happens When Ellen Launches an Information Query?

As Ellen seeks to buy the coffee that best matches her personal price, quality, and value, she uses her handheld computing device to launch a query that makes use of a type of Internet search engine. As illustrated in Figure 2, each of these shopping support tools has two basic functionalities.

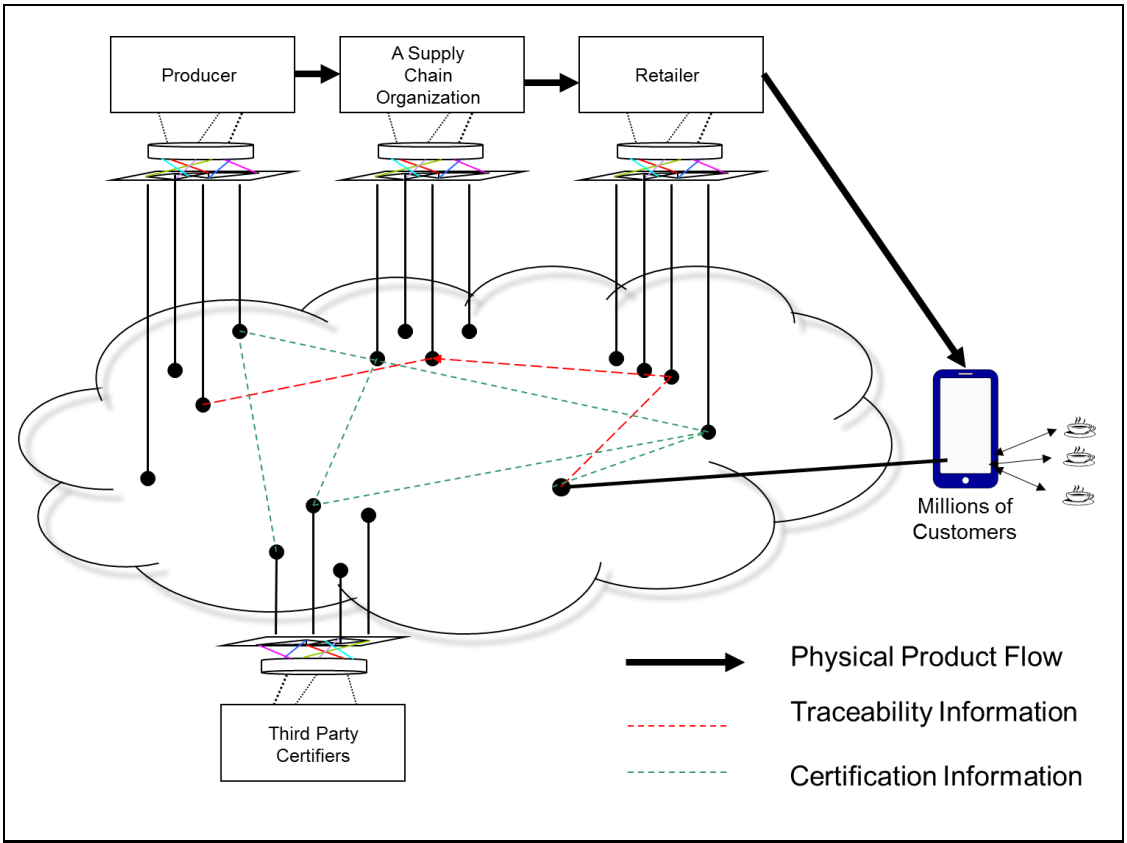

Figure 2. Tracing a Product Back to its Source to Check Endorsements and Third-party Certifications

First, as illustrated by the red dashed lines in Figure 2, the shopping tool can trace back product provenance from point of purchase to point of production. The ability to complete this function is created when all organizations in the supply chain provide a basic abstract of their shipping and receiving relationships. The shopping tool seeks information from the retailer that sold Ellen her product and queries it concerning the supplier of the product. Then the shopping tool moves up the supply chain using a sequence of "shipped to" and "received from" relationships to reconstruct the supply chain that delivered her product (in this case, coffee) to market. In order to increase the accuracy and reliability of this source-tracing information, another type of information aggregator industry will emerge, creating more integrated source databases by continuously "crawling and trawling" through available Internet data to create more accurate and easy-to-access source traces.

[5] See XBRL: eXtensible Business Reporting Language site (2013) at http://www.xbrl.org/.

Communications of the Association for Information Systems

The second functionality of Ellen's shopping tool connects certification information to product and supply chain information. This functionality is abstractly represented by the green dashed lines in Figure 2. Using a system of transparent and verifiable certification documents, third-party certifiers (such as government agencies or NGOs) have inspected the production and logistics facilities used to manufacture and transport materials and have attached their certification information to the product, also providing data provenance.

How Do Consumer Advocates Provide Product Endorsements and Ratings to Help Ellen Choose?

Actually Ellen rarely uses either the endorsement or ratings functionalities of her handheld shopping support tool. Once she did view a tutorial on how the system works, but she never got to be really good at using it. Her Facebook friend Rajesh, however, frequently reviews products and the organizations that produce them through the system. As Ellen knows Rajesh and values his opinion, if she sees he has rated a product or endorsed someone else's review, she will pay more attention to that information. The same goes for the other contacts in social networks in which Ellen participates.

As an environmental activist, Rajesh knows that the trickiest part of the system turns out to be in unraveling the certification and endorsement information. There exists a complex array of certifications with a variety of norms and standards, which makes it hard for consumers to understand the true meaning of each seal. Moreover, desire for market penetration of value-based consumption provides economic incentives for corporations to want to appear to be value-conscious. "Green-washing" has been an implicit goal of many marketing campaigns.

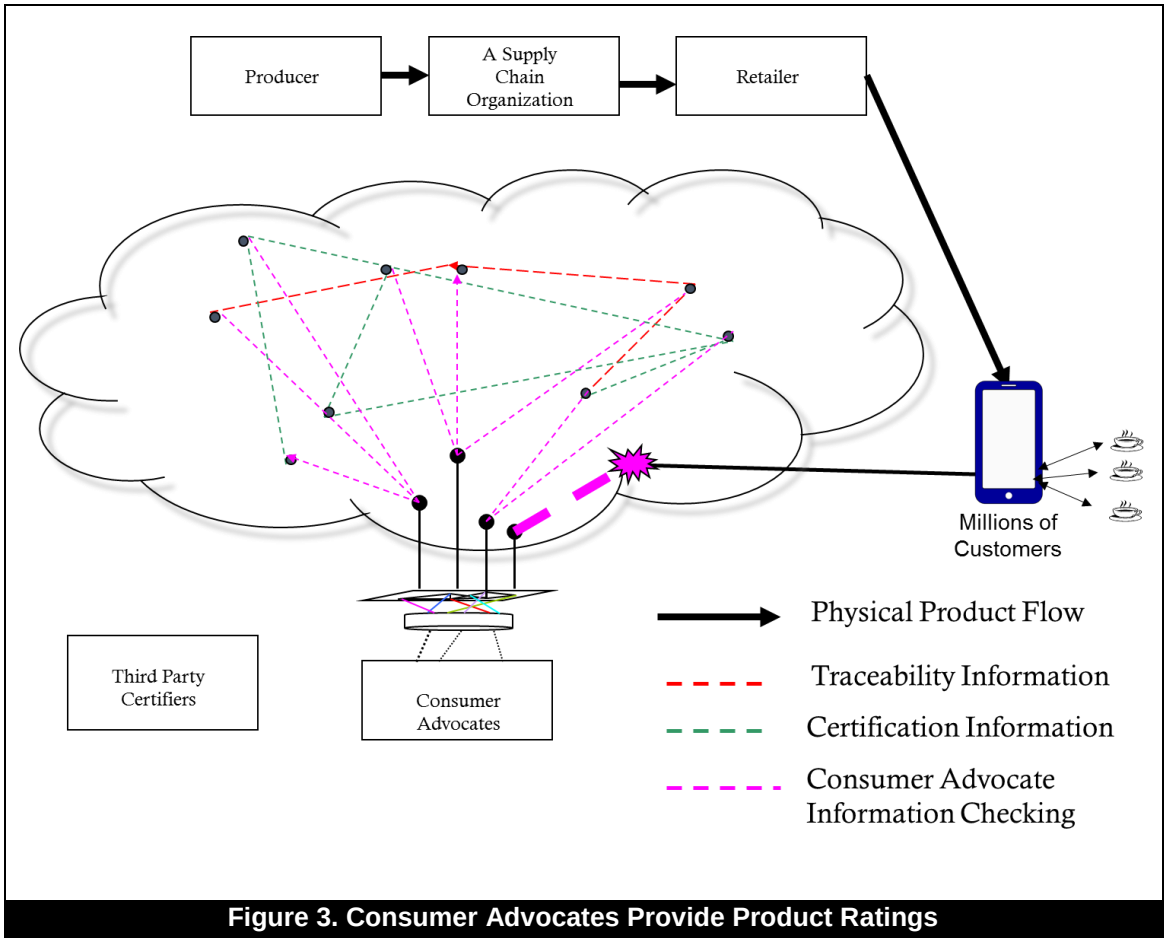

Figure 3. Consumer Advocates Provide Product Ratings

Ellen, like most value-conscious users, may rely on product evaluations that came from several consumer advocate groups that she had come to know and trust (dashed pink line in Figure 3). These consumer advocate groups will make their own product ratings available through social networking sites that they could carefully control or through mobile applications such as GoodGuide. They will make it their business to carefully comb through all the information available on the I-Choose system, checking and rechecking information sources carefully. Therefore, their rating results can be drilled down to the details of the information elements on which the ratings are based.

How Do Certification Relationships Work in I-Choose?

A key technical problem that needed to be solved before I-Choose could become an operational system was how to represent trusted certification and endorsement information on the system. Our initial efforts to define the I-Choose standards made evident the need to clearly define differences in the meaning of different seals and logos used in product packaging and marketing, as well as the norms and standards followed by each of them. Consumers need to know the difference between a voluntary regime such as the Mexican Corporate Social Responsibility Seal (which is mainly based on a self-assessment and the goodwill commitment of the company), organizational certifications involving a third-party inspection such as the World Fair Trade Organization (which also certifies retailer goodwill, considering all products he or she commercializes as fair trade), or product regimes such as the Fair Trade Labeling Organization Certification (which involves an independent third-party on-site certification of producers and other participants in the supply chain).

Moreover, specific meanings of each certification need to be more transparent. In this way, all certifying authorities, either national governments or international organizations, need to make their standards and criteria public, making agreements about meanings of each of them. This process might show important intersections among certifications, making it attractive for certifiers to get an agreement on meanings and definitions to share information not only with consumers, but also among themselves. A shared set of norms not only makes the meaning of each certificate clearer and more transparent to consumers like Ellen, but also helps certifying authorities to build trust in each certificate, in turn making certification processes cheaper to the producers and other supply chain actors.

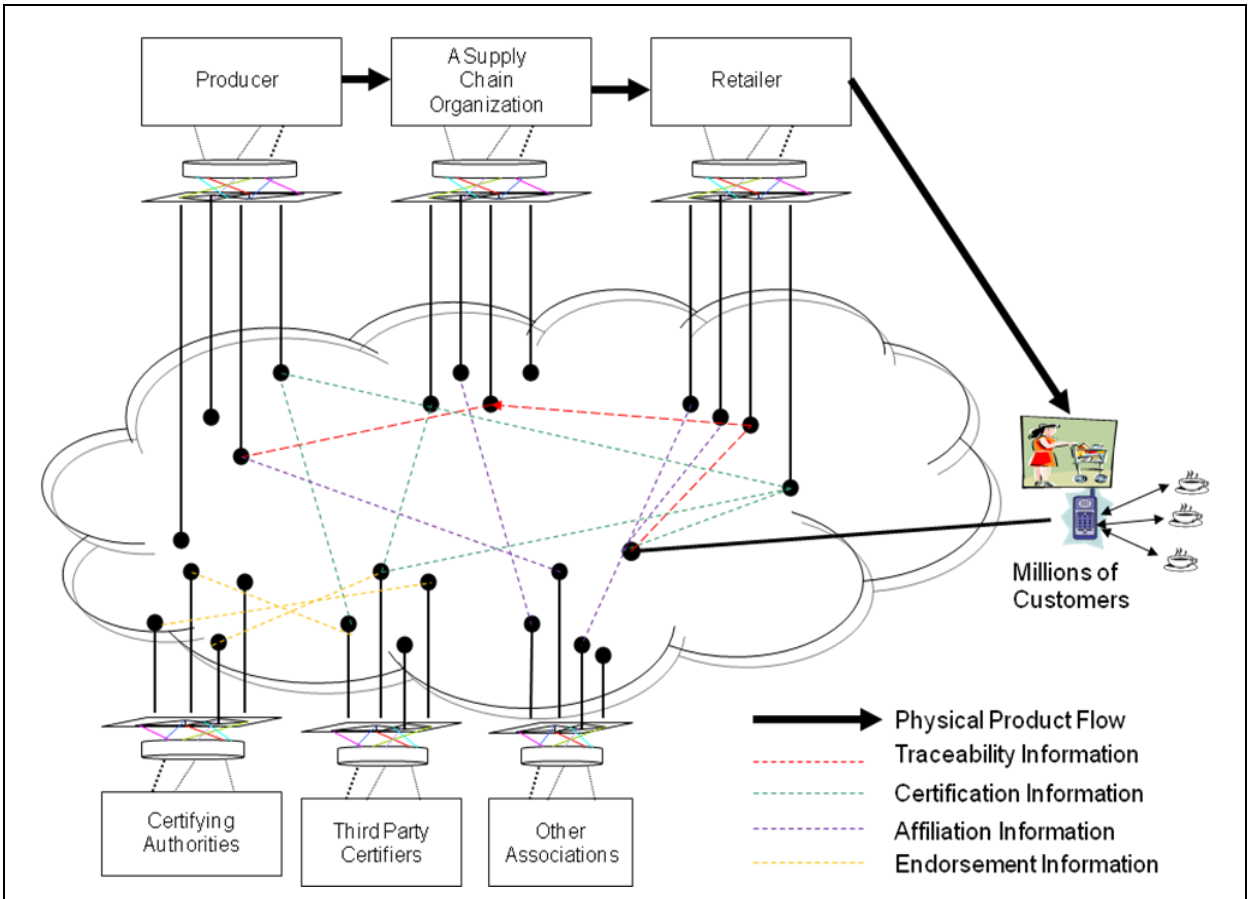

Figure 4. Certification and Endorsement Relationships in the I-Choose System

Figure 4 illustrates in more detail how these types of certification and endorsing relationships will be handled by the I-Choose system. First, the system clearly differentiates certifications from other affiliations or associations. That is to say, consumers can know when a product or organization has passed a formal independent certification process, and when an organization has internal self-assessment mechanisms to show its commitment with some specific values related to a particular association (such as Catholic Relief Services, Mexican Center for Philanthropy, or the Roundtable on Sustainable Palm Oil). All formal certification processes are endorsed by digital certificates that use current security technologies and can be authenticated and trusted.

What Is the Relationship Between I-Choose Information Standards and Other Information Standards?

Figure 5 answers a final question about the I-Choose system as an overarching set of information standards for all kinds of products being delivered to retail markets: What are the relationships between the I-Choose information standards and other sets of information standards, such as ubiquitous product codes (UPC) or eXtensible Business Reporting Language (XBRL), adopted as a standard to share corporate financial reports?

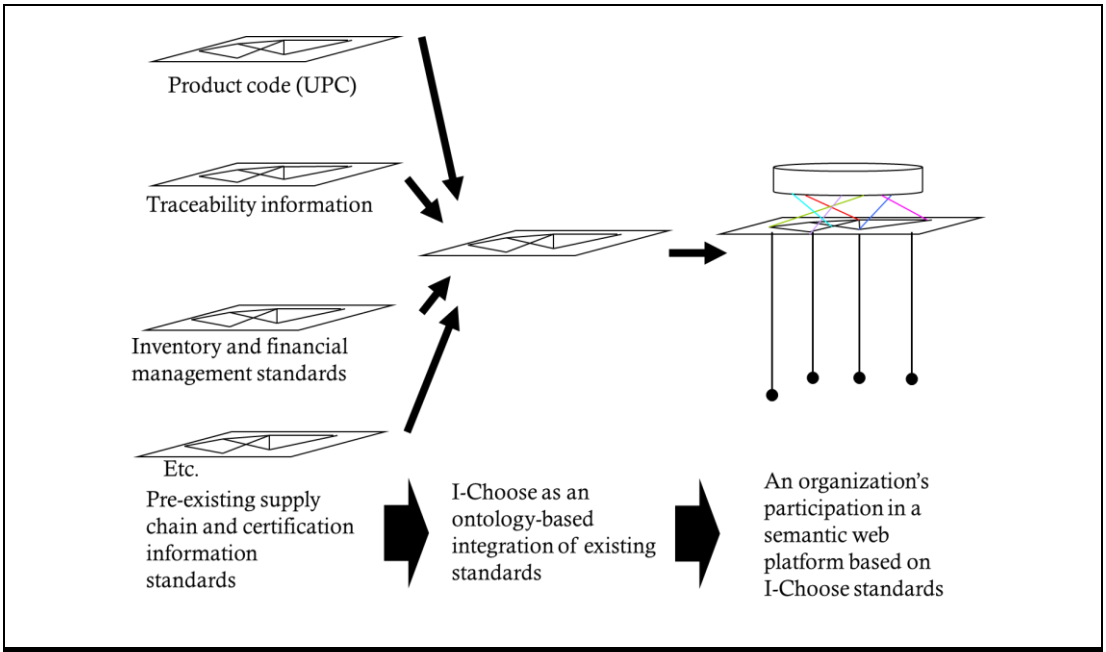

Figure 5. I-Choose Is an Ontology-based Integration That Relies on Pre-existing Information Standards and Enables Organizations to Share Data with XML

As illustrated in Figure 5, the I-Choose system constitutes an integrated ontology to explicitly map out the relationships among all pre-existing information standards to support supply chain operations. To the best of our knowledge, a key component not yet well developed is the integration of certification and endorsement information standards, alongside the more developed product identification, supply chain logistics, and financial management standards. These standards are critical for customers like Ellen who want to trust the information being provided through their handheld devices and for consumer advocates, serving as information aggregators, to participate in the system.

IV. CURRENT EFFORTS ON I-CHOOSE AS A MACRO-SCALE SOCIO-TECHNICAL SYSTEM

Our current research efforts in the development of an I-Choose system are organized into three main work areas. The first one is related to the development of a prototype ontology to describe certification processes and standards as a source of trust for information shared throughout the supply chain. The second line of work is oriented toward the development of a policy framework and a governance system to ensure fairness in the system, as well as the presence of appropriate processes and guidelines to share high-quality data. Our third line of work consists of the analysis of a sustainable business model for I-Choose standards and governance through a simulation model. We will briefly describe these three lines of work in the following paragraphs.

Conversations that the project team has had with members of the coffee supply chain revealed that capturing the complexities of the entire supply chain requires a simplified and generalizable ontology-based approach. Our exploration also shows that a key missing link for building an effective interoperable data architecture for a sustainable supply chain for commodity products such as coffee is an ontology-capturing certification and inspection (C&I) process.

We are developing several use cases reflecting different levels of complexity found in the certification and inspection processes. First, we will create a simplified ontological realization of the C&I processes primarily based on the use cases supported with a mock-up data table. In a second step, the robustness of this first iteration will be further developed and tested on a real data table gathered from a third-party certifying organization. We will then replicate the approach with a different level of data completeness, also expanding the scope to include the full range of activities involved in the C&I process.

The real-world ontological realization of the C&I process will enable a consumer advocate, such as Rajesh, to ascertain and verify the truthfulness of the information attributes of an item such as coffee that is marketed as a sustainable and eco-friendly product. We are building partnerships with certifying organizations across different geographical locations in order to continue this line of our work.

Our research findings to date also demonstrate that transparency of product information cannot be achieved by either private companies or government agencies acting alone. These actors must collaborate in order to achieve the benefits of a more transparent supply chain—increased public access to product data that can inform consumer choice, greater innovation that supports economic growth, and more efficient forms of regulation.

In terms of governance, we envision a collaborative hub where public, private, and nonprofit stakeholders work together to formulate standards that support product information disclosure. We call this mechanism a "data commons." The data commons involves two tiers of data sharing: (1) information that is shared among the community of participants according to commonly agreed rules and procedures via internal APIs and keys and (2) the timely and transparent release of product data in accessible formats via published external APIs. This two-tier system is designed to increase trust among the participants, protecting sensitive corporate information while promoting the progressively more ambitious release of data. A peer-to-peer benchmarking process, linked to periodic review by consumer champions, and existing channels of legal redress, promotes the protection of consumer privacy and the security of the system.

With the purpose of exploring the ways in which the I-Choose system could penetrate the market, and informed by the set of governance principles described in the previous paragraphs, we have developed a preliminary simulation model. The model in its current form includes the universe of producers who could potentially contribute to the I-Choose data commons as well as consumers who elect to use the information to make better retail purchase decisions. Producer interest in the data commons is assumed to be influenced by a consideration of the costs and benefits implied in joining the I-Choose initiative. Consumers are assumed to become active users when there are many producers and suppliers contributing information to the system and when the information provided by the system is both trustworthy and of high quality. The model makes a series of assumptions about how an open governance structure can contribute both to high-quality and trustworthy data.

We had expected that the model would be able to give us insights into pathways of growth for the overall data commons—such as, under what conditions will consumer adoption match producer buy-in to produce a growing market with increasing market share? Our preliminary modeling efforts provided two surprise results.

First, the market simply did not grow. We had expected that our assumptions about positive word-of-mouth built into the model would provide an engine of growth. Instead, the data commons was drawn into a downward spiral. Providers did not join the system because there was not a large enough user base. Consumers were not attracted to the system because it was not populated with data from enough users to be useful. We discussed the possibility that some form of private promotion of the data commons in the form of large-scale marketing efforts was necessary for a consumer-produced system based on I-Choose to flourish. Indeed, with enough marketing support the simulated information commons could become sustaining even with low quality information being provided.

Second, quality of governance and information appears to drive final market equilibrium and market share. The model as formulated led to the surprising (for us) result that higher levels of market penetration were associated with higher quality and more open governance. If this result proves stable, we will find that openness of governance drives the overall share of market penetration, whereas marketing and the business model (who pays for system development) drives whether or not the market takes off and how quickly the market grows.

Overall, these three lines of work can be understood as the development of three different prototypes—a prototype ontology, a prototype governance mechanism, and a prototype model of the market. The three prototypes will be then introduced to stakeholders in the coffee supply chain to make them a more robust proposal and to find alternative paths to the market.

V. DISCUSSION AND IMPLICATIONS

We believe that the creation and implementation of FIPP-like supply chain information systems have the potential to transform the nature of retail markets and trade. The I-Choose research program and prototypes described in this article are an example of the type of research that we hope will enable these transformations.

Moving forward, we believe that the most exciting developments in the future will involve questions that cut across many different knowledge domains such as economics of information, supply chain management, market

regulations, international trade, and governance. These knowledge domains are, from our perspective, inside and across the boundaries of the IS field, particularly in the frontiers of information systems, marketing, operations, public policy, and industrial ecology. For example, entrepreneurs will be interested in the implications of cross-cutting questions. Our description of I-Choose implies that FIPP information systems might promote the development of widespread consumer decision support systems and recommendation agents. In this way, some key questions in the area could be: *What new forms of consumer decision support systems will come into play? What are the main characteristics of these systems, and how will they change consumer decision processes?* or *Will a new form of retail industry emerge around portable consumer decision support technologies?*

FIPP systems may also modify ways in which supply chains align to respond to consumer demand or even ways in which consumers communicate their needs to supply chain participants. Thus, consumers may use FIPP information to seek out supply-chain configurations that meet their basic values (and retailers might develop new ways to dynamically reconfigure supply chains to meet this new kind of demand), pointing toward a radical possibility to re-orient consumer retail markets. Retail organizations will become less and less in the business of bricks and mortar, creating spaces to shelve and display goods. Rather, they will be providing their customers with portable shopping decision-support tools that will enable customers to place demands on dynamically reconfigurable supply chains, getting from these systems the types of products that they want produced in the places, by the people, and in the conditions that are preferred by the individual customer. Relationships among customers, retailers, producers, and the many links in these continuously dynamic and reconfigurable supply chains will be in constant flux, guided by new rules of competition and collaboration.

Once entrepreneurs invent and deploy these new retail structures (and once governments respond with innovate forms of market-driven regulation), theorists and academic researchers will scramble to catch up. Researchers will seek to define new forms of public-private governance that explain the newly emerging forms of coordination hubs and standards, and their wider impacts on market regulation and trade. Perhaps more dramatically, economists will be joining forces with information scientists and with organizational and behavioral theorists to revise neo-economic market theory to explain new patterns of collaboration, cooperation, and competition among and between supply chain partners.

Finally, we believe that designing and developing FIPP-like systems, as well as understanding their impacts on international markets, require methods that can synthesize and integrate concepts, ideas, data, preferences, and knowledge from a range of diverse individuals, disparate sources, and multiple disciplines. Information systems qualitative and quantitative research methods, such as simulation involving analytical models, design science, prototyping, and other socio-technical approaches, will play an important role in these developments.

ACKNOWLEDGMENTS

This research is partially supported by the National Science Foundation (NSF) under Grants No. 37656 and IIS-0540069, and the Consejo Nacional de Ciencia y Tecnología (CONACYT) under Grants No. 84082 and 133670, and the Canadian and COMEXUS Fulbright Commissions. Any opinions expressed in this material are those of the authors and do not necessarily reflect the views of NSF or CONACYT.

REFERENCES

Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. The author(s) of the Web pages, not AIS, is (are) responsible for the accuracy of their content.
4. The author(s) of this article, not AIS, is (are) responsible for the accuracy of the URL and version information.

Berniers-Lee, T. (1998) "Why RDF Model Is Different from the XML Model", http://www.w3.org/DesignIssues/RDF-XML.html.

Bray, J., N. Johns, and D. Kilburn (2011) "An Exploratory Study into the Factors Impeding Ethical Consumption", *Journal of Business Ethics*, (98)4, pp. 597–608, http://dx.doi.org/10.1007/s10551-010-0640-9.

Carrington, M., B. Neville, and G. Whitwell (2010) "Why Ethical Consumers Don't Walk Their Talk: Towards a Framework for Understanding the Gap Between the Ethical Purchase Intentions and Actual Buying Behaviour

of Ethically Minded Consumers", *Journal of Business Ethics*, (97)1, pp. 139–158, http://dx.doi.org/10.1007/s10551-010-0501-6.

Caswell, J.A., and D.I. Padberg (1992) "Toward a More Comprehensive Theory of Food Labels", *American Journal of Agricultural Economics*, (74)2, pp. 460–468.

Eamich, A. (2007) "Statement of Dr. Richard Raymond Regarding Increased Testing and Re-inspection of Imported Meat and Poultry Products from Canada," November 27, 2007, http://www.fsis.usda.gov/News_&_Events/NR_110307_01/index.asp (current June 4, 2008).

Goleman, D. (2009) *Ecological Intelligence: How Knowing the Hidden Impacts of What We Buy Can Change Everything,* New York: Broadway Books.

Graham, M., and H. Haarstad (2011) "Transparency and Development: Ethical Consumption Through Web 2.0 and the Internet of Things", *Information Technologies & International Development*, (7)1, pp. 1–18.

Hevner, A.R., S.T. March, J. Park, and S. Ram (2004) "Design Science in Information Systems Research", *MIS Quarterly*, (28)1, pp. 75–105.

Hobbs, J.E. (2004) "Information Asymmetry and the Role of Traceability Systems", *Agribusiness*, (20)4, pp. 397–415.

Kim, G.-S., G. Lee, and K. Park (2010) "A Cross-National Investigation on How Ethical Consumers Build Loyalty Toward Fair Trade Brands", *Journal of Business Ethics*, (96)4, pp. 589–611, http://dx.doi.org/10.1007/s10551-010-0486-1.

Low, W., and E. Davenport (2007) "To Boldly Go … Exploring Ethical Spaces to Re-politicise Ethical Consumption and Fair Trade", *Journal of Consumer Behaviour*, (6)5, pp. 336–348, http://dx.doi.org/10.1002/cb.226.

Luna-Reyes, L.F., J. Zhang, R. Roy, D.F. Andersen, A. Whitmore, and D.L. Andersen (2013) "Information Strategies to Support Full Information Product Pricing: The Role of Trust", *Information Polity: The International Journal of Government & Democracy in the Information Age*, (18)1, pp. 75–91.

Moreau, L. (2010) "The Foundations for Provenance on the Web", *Foundations and Trends in Web Science*, (2)2–3, pp. 99–241.

Organic Trade Association (2011) "2011 Organic Industry Survey", Organic Trade Association, Brattleboro, VT.

Peffers, K., T. Tuunanen, M. Rothenberger, and S. Chatterjee (2007) "A Design Science Research Methodology for Information Systems Research", *Journal of Management Information Systems*, (24)3, pp. 45–77, http://dx.doi.org/10.2753/MIS0742-1222240302.

Regattieri, A., M. Gamberi, and R. Manzini (2007) "Traceability of Food Products: General Framework and Experimental Evidence", *Journal of Food Engineering,* (81)2, pp. 347–356.

Ricardo, D. (1817) *On the Principles of Political Economy and Taxation,* London: John Murray.

Smith, A. (1776) *Inquiry into the Nature and the Causes of the Wealth of Nations,* London: W. Strahan and T. Cadell.

Watts, S., and G. Wyner (2011) "Designing and Theorizing the Adoption of Mobile Technology-mediated Ethical Consumption Tools", *Information Technology & People*, (24)3, pp. 257–280, http://dx.doi.org/10.1108/09593841111158374.

Whitmore, A., D.F. Andersen, J. Zhang, and L.F. Luna-Reyes (2010) "A Policy Framework for Evaluating Full Information Product Pricing (FIPP) Regimes", *Proceedings of the 11th Annual International Digital Government Research Conference, dg.o 2010,* May 17–20, 2010, Puebla, Puebla, México.

ABOUT THE AUTHORS

Luis Felipe Luna-Reyes is a Professor of Business at the Universidad de las Américas Puebla in Mexico. He holds a Ph.D. in Information Science from the University at Albany, SUNY. Luna-Reyes is also a member of the Mexican National Research System. His research focuses on electronic government and modeling collaboration processes in the development of information technologies across functional and organizational boundaries.

Jing Zhang is an Associate Professor of Management at Clark University. Her research focuses on inter-organizational information and knowledge sharing, the organizational impact of technology and innovation, and information technology support for sustainable consumption and sustainable supply chains. She has published in the *European Journal of Information Systems*, *Public Performance and Management Review*, *Information Technology and Management*, and the *International Journal of Enterprise Information Management*, among others.

Andrew Whitmore is an Instructor in the Department of Information Systems and Decision Science at the University of South Florida. His primary areas of research interest include public sector information systems and the "big data" movement. He holds a Ph.D. in Information Science from the University at Albany, SUNY, an MS in Information Systems from Johns Hopkins University, and a BA in Economics from Cornell University.

Holly Jarman is a Research Assistant Professor with the Center for Law, Ethics, and Health and the Department for Health Management and Policy at the University of Michigan. Jarman researches the impact of trade and economic policies on domestic programs which provide healthcare, support public health, protect the environment, or promote worker rights. Her work has appeared in several peer-reviewed journals, including the *Journal of Public Health Policy*, *Tobacco Control*, *Social Policy and Administration*, and *Public Policy and Administration*.

Sergio Picazo-Vela is an Associate Professor in the Business School of the Universidad de las Américas Puebla in Mexico. He received his Ph.D. in Business Administration from Southern Illinois University Carbondale. His research interests include e-commerce, information technology outsourcing, cyberloafing, social media sites, and e-government.

Deborah Lines Andersen is an Associate Professor of Information Science and Informatics in the College of Computing and Information at the University at Albany, SUNY. Her research interests are in knowledge management with particular emphasis on public libraries, technology in libraries, and information policy. Her recent publications have focused on information distribution across supply chains and marketing of public library services from an international perspective. She was a 2011–2012 Carlos Rico Fulbright Scholar, conducting research in Montreal, Canada, and Cholula, Mexico.

Giri Kumar Tayi is a Professor of Management Science and Information Systems at the University at Albany, SUNY. He obtained his Ph.D. from Carnegie Mellon University and his research and teaching interests are interdisciplinary and span the fields of information systems, operations management, and operations research. His papers appeared in top-tier academic journals such as *Operations Research, Management Science, MIS Quarterly, IEEE Transactions, Networks, Naval Research Logistics, EJOR, Journal of Combinatorial Optimization, INFORMS Journal of Computing, Journal of Computer Security, Government Information Quarterly,* and *Communications of the ACM*.

Theresa A. Pardo is the Director of the Center for Technology in Government at the University at Albany, SUNY. She holds Research Associate Professor appointments in Public Administration and Policy at the Rockefeller College of Public Affairs and Policy, and in Informatics at the College of Computing and Information. Theresa is a co-developer of the top-ranked Government Information Strategy and Management concentration at the University of Albany and is president-elect of the Digital Government Society, a global multi-disciplinary organization of scholars and practitioners interested in the development and impacts of digital government.

Djoko Sigit Sayogo is a Ph.D. candidate in the Rockefeller College of Public Administration and Policy, the University at Albany, SUNY, and the recipient of a Fulbright Presidential Scholarship. His research interests include e-government, collaborative network, data sharing, and smart disclosure policy.

Joanne S. Luciano is a Research Associate Professor at the Tetherless World Constellation, Deputy Director of the Rensselaer Web Science Research Center, President and Founder of Predictive Medicine, Inc., and formerly of Harvard Medical School and Massachusetts General Hospital. Luciano researches the use of mathematics and computational approaches for facilitating the integration of life science and biomedical knowledge to affect health outcomes. She is a recognized pioneer in the application of semantic technologies to healthcare and life science, and more recently defined the field of health Web science. Her work has appeared in several peer-reviewed journals

including *Nature Biotechnology, Journal of Medical Internet Research, Journal of Biomedical Semantics, Journal of Web Semantics, Pharmacogenomics,* and *BMC Bioinformatics.*

David F. Andersen is a Distinguished Service Professor of Public Administration, Public Policy, and Information Science at the Rockefeller College, University at Albany, SUNY. His work centers on applying system dynamics, systems thinking, and information technology approaches to problems in the public, not-for-profit, and private sectors, especially using group modeling approaches. He has served as a technical consultant to public and not-for-profit agencies in the federal, state, and local sectors as well as to corporate clients in North America and Europe. He is co-author of *Introduction to Computer Simulation: The System Dynamics Modeling Approach*, winner of the Forrester Award in 1983.

Communications of the Association for Information Systems

ISSN: 1529-3181

Communications of the Association for Information Systems